Center Innovation Fund: GSFC CIF

Ultrafast Laser Material Processing: Welding, Drilling, and Waveguide Inscription

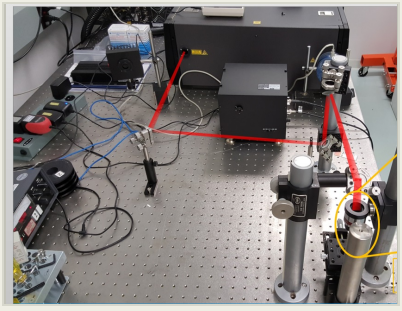
Completed Technology Project (2016 - 2017)

Project Introduction

This CIF represents an initial effort to leverage current university-based research for an advanced, micron level manufacturing technique suitable for sensors and miniature components for instruments. Key to this process is tight control of an Ultrafast (150 femtosecond) laser. This technique also has a direct path to enhancing the new and exciting area of photonics integrated circuits (PIC). Future opportunities such as ESTO's ACT, IIP, EVIs, EVM's, Planetary Sciences' PIDD, MatiSSE, New Frontiers, Discovery, etc. will require more advanced laser instrumentation to meet their science requirements. These systems would, for example, need new wavelengths for generation via nonlinear optical frequency conversion, addition of a highly sophisticated PIC to realize tunable/single frequency laser sources, and "optical features" such as volume Bragg gratings that act as end reflectors or spectral control mechanism in laser resonator. This new laser fabrication technology could be instrumental in enabling such developments. PICs would help in integration of electro-optics components in a small package thus reducing size, weight and power (SWaP) for resource-limited missions. Near term goals are to demonstrate glass-to-metal welding and micromachining shortly thereafter.

Anticipated Benefits

This effort seeks to develop new material processing capabilities by using an Ultrafast laser to perform welds between dissimilar materials (such as glass to metal), laser drilling of small holes without heating of the surrounding material, and ultimately inscribing waveguides inside of glass; this last application is of great interest. When brought to a focus within a glass the high peak intensities of the laser pulse can change the index of refraction of the material. This allows waveguides and other optical structures to be written directly within bulk glass. This is a critical capability which will greatly facilitate the creation of Photonic Integrated Circuits. Also, of special near-term interest to NASA is the capability of Ultrafast lasers to weld glass to metal, especially at small sizes for lab-on-a-chip application, which can replace the currently used epoxies that are leak-prone and may outgas onto sensors/optics.



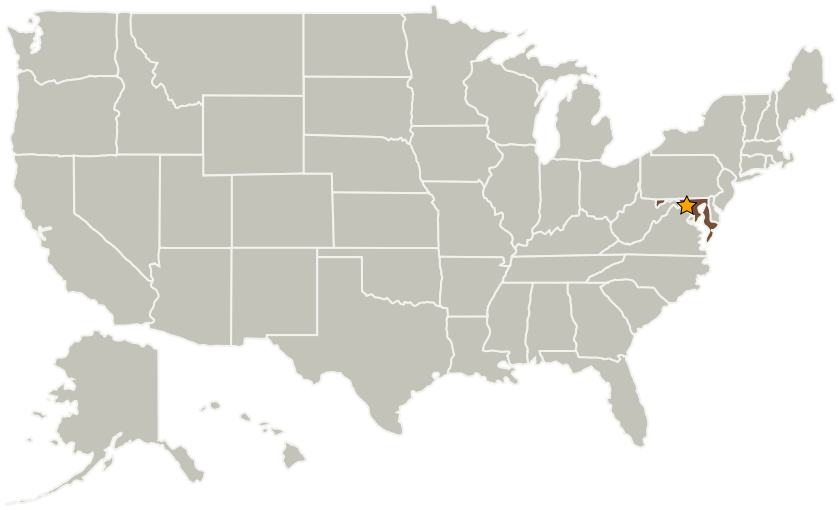
Beampath of the femtosecond laser

Table of Contents

Ultrafast Laser Material Processing: Welding, Drilling, and Waveguide Inscription

Completed Technology Project (2016 - 2017)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Innovation Fund: GSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

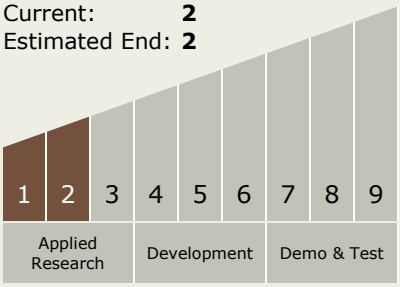
Peter M Hughes

Principal Investigator:

Robert E Lafon

Technology Maturity (TRL)

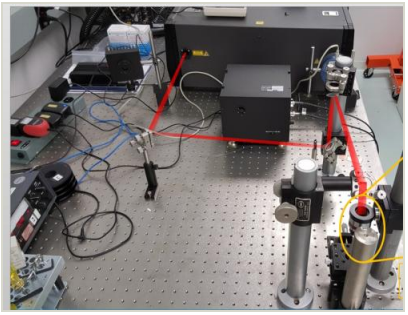
Start: **1**
Current: **2**
Estimated End: **2**



Ultrafast Laser Material Processing: Welding, Drilling, and Waveguide Inscription

Completed Technology Project (2016 - 2017)

Images



Untitled Image 2
Beampath of the femtosecond laser
(https://techport.nasa.gov/image/27732)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.5 Lasers

Target Destination

Foundational Knowledge